Journal of Environment and Earth Science
ISSN 2224-3216 (Paper) ISSN 2225-0948 (Online)
Vol.5, No.20, 2015

The eco-sensitive carwash technology in management of waste water in river ecosystems

Tom Nyangau[1], Nancy mayoyo[2].
[1] Faculty of Agriculture and Natural Resources Management. Department of Environmental Science. Kisii University P.O Box 408 -40200 Kisii – Kenya
2 Faculty of Education and Human Resource Development. Department of Educational Foundations-Sociology, Kisii University P.O Box 408 -40200 Kisii – Kenya

Abstract

Kenya aspires to become a middle income country as envisioned in Kenya vision 2030. This means better living standards powered by the middle level income population. This will translate to many cars on our roads, highly consumptive economy that generates more solid and liquid wastes drained into water sources, air and land. Currently the estimated number of cars on Kenyan roads is 935,000 and each of them is at least valeted two or three times a week, either in a constructed car wash, along rivers, urban pavements, or within the compound. The by-products of car valeting in form of grease, tar, detergents, oils, soil, heavy metals such as chromium from paint, lead from acid accumulators, mercury from stabilization system accompanies storm water or drainage systems and enter into the urban water systems (rivers, lagoons, fish ponds and pans) Water contaminants such as grease (kills fish, micro and macro-organisms) heavy metals such as iron and mercury have bioaccumulation properties entering the food chains destroying the spectrum of food webs. Solid particles i.e. grease, oil and soil lower water quality and associated economic costs of water usability affecting businesses and downstream use of the river water systems. Therefore the eco-sensitive carwash technology is a new innovation with the following objectives: To clean and improve water quality of urban water systems, Increase biodiversity in urban water systems, Increase clean water supplies for domestic, industrial and agricultural use and decrease the disease burden of water borne diseases. The technology works based on four scientific principles of physical filtration, contaminant adsorption, recycling and backwashing as a cleanup mechanism. ESCT design constitute of a cylindrical container that assumes a man hole like structure arranged from top-bottom materials of decreasing sizes as follows: large gravel, pebbles, sand, cellulose, activated carbon and cellulose to do filtration, adsorption and backwashing as regenerative clean up mechanism. Successive implementation of the technology will lead to; Carwash activities being accepted and legitimized by the county, other counties and international governments, sources of employment in terms of people doing construction and training, source of clean water for domestic, industrial and agricultural use, boost urban farming associated with urban irrigation.

Key words; eco-sensitive, carwash, physical filtration, water quality, biodiversity and technology

1.1 Introduction

Almost a fifth of all ill health in poor countries and millions of deaths can be attributed to environmental factors, including climate change and pollution, according to a report from the World Health Organization. Water is increasingly becoming a scarce natural resource due to the above factors driven by anthropogenic influences.

Unsafe water, poor sanitation and hygiene as well as indoor and outdoor air pollution are all said to be killing people and preventing economic development. In addition, says the World Health Organization, increasing soil pollution, pesticides, hazardous waste and chemicals discharged to the environment are significantly affecting the health of aquatic lives.

Sources of water pollution like industrial wastes from factories have been greatly reduced in recent years. Now, more than 60% of water pollution comes from things like runoff from washing cars, fertilizer from farms and lawns, and litter. All these sources add up to a big pollution problem. So, the biggest source of water pollution today is not industry; it is actually household activities. The realization that storm drains flows directly into the environment untreated is the first step towards sustainable environmental management. When cars are washed in the driveway, river banks or on the street, the dirt, oil, and detergent laden water runs into storm drains and then directly into streams, rivers, and lakes. Just as soap and other detergents destroy dirt and organisms on car; it will do the same to the organisms in creeks and other bodies of water. For instance, the detergents found in car wash cleaners affect fish populations mainly through the power of the surfactants to destroy the external mucus layers protecting fish from bacteria and parasites, in addition to severe damage to the gills. Most fish die when detergent concentrations are near 15 parts per million (ppm); however, detergent concentrations as low as 5 ppm will kill fish eggs. Also, many of the commonly used soaps contain phosphates, which remove oxygen from the water. This depletion of oxygen has a detrimental effect on aquatic life. So from a simple act of washing vehicles in environmentally sensitive places/sites, the scum and oily grit from the motor vehicles and the soap used to clean them directly harms our precious natural resources. Globally there is a rise in waterborne diseases such as typhoid, cholera, dysentery, heavy metal poisoning, skin diseases and allergies. All these are alluded to water contamination.

1.1 Problem Statement and Justification

Outdoor car washing has the potential to result in high loads of nutrients, metals and hydrocarbons during dry weather conditions in many watersheds, as the detergent-rich water used to wash the grime off our cars flows down the street and into the storm drain, affecting the aquatic ecosystem functions and also posing long term health impacts to the direct users of water resources. Car washing is a common routine for residents and a popular way for the youth to raise funds. This activity is not limited by geographic region, but its impact on water quality is greatest in urban areas with higher concentrations of automobiles. Currently, only a few pollution prevention programs incorporate proper car washing practices as part of an overall message to residents on ways to reduce point and nonpoint source pollution. Other programs have gone as far as providing groups with equipment and facilities to undertake these activities which in turn alleviate the problems associated with polluted waste water entering the storm drain system.

The eco-sensitive carwash project offers an amenable solution on waste water management that is currently unavailable and describes the process of physical filtration that ensures the contaminated water from the carwash activities does not end up in water bodies from which sustainable conservation of the natural water ecosystem to support robust and diverse aquatic lives originate.

1.2 Objectives

1. To design physical filtration technology to clean waste water from carwash points
2. Increase quantities of clean water supplies for domestic, industrial and agricultural use from polluted waste water.
3. Decrease the disease burden of water borne diseases by enhancing more supply of clean water.

2.0 Literature Review

Environmental pollution with poisonous and dangerous heavy metals is a main concern in modern societies (Chong et al., 2000). These metals are naturally present in different layers of the earth and human interfaces including urban, industrial and agricultural sewage, mine discovery and exploitation, fossil fuel consumption, etc. increase their accumulation in the environment (Fergusson, 1990). Sewage from industries, such as mine,

weaving, leather, tanning, electroplating using zinc, galvanizing dyeing material, metal extraction and fusion (Ahluwalia and Goyal, 2007), manufacturing electrical equipments, alloys, battery, insecticides, sludge resulted from sewage filtration, the ash produced from burning trash and garbage, and radioactive processes, contain significant amounts of ions of poisonous metals (Ahluwalia and Goyal, 2007). Heavy metals such as zinc, lead and chrome have various applications in basic engineering tasks including paper production, leather tanning, organic chemicals and oil chemical based fertilizers. Ions of heavy metals potentially endanger human health and lead to physical harms and even threatening diseases such as irreversible harm to body's vital systems (Malik, 2004).

By developing several mechanisms these metals remove the balance in live beings, especially humans, and result in a wide range of consequences and disorders (Chong et al., 2000). The most important of these consequences include carcinogenicity, effects on central and peripheral nervous system, skin diseases, blood disorders, cardiovascular diseases, kidney harm and mass accumulation in tissues. Most effects of such metals on human health are not known yet. Metal ions accumulate in the environment and enter food chains (Volesky and Schiewer, 2000). Therefore, removal of heavy metals from aqueous environment is a significant public health issue and can be mitigated through removal of heavy metals from waste water emanating from carwash activities, industrial activities, urban runoffs, agricultural drained water and mines using eco-friendly mechanisms to neutralize their poisonous effects.

There are several methods to remove heavy metals from the environment which mainly involve physical, chemical and biological ways (Zhang et al., 2007). Current physical methods include physical filtration, normal and membrane filtration (nano-filtration), reverse osmosis, surface absorption in stable and floating beds, coagulation – flocculation and flotation (Kurniawan et al., 2006).

3.0 Methodology

3.1 Project location

Kisii town is the head quarter of Kisii County and is located in Western Kenya, on Latitude: 0° 41' 0 S and Longitude: 34° 46' 0 E. It has an approximate population of 200,000 who depend on the ecological services offered by the natural water bodies. Kisii town is found in a steep and rugged *terrain which* particularly is prominent to the rivers and streams traversing the town.

The project targets already established car washing bays and carwash hotspots along the rivers of Kisii County especially those that traverse the CBD of the county headquarters. On average 40 vehicles are cleaned from each of carwash hotspots of the town (Daraja moja, along Daraja moja – Ram hospital, Nyambera, Daraja Mbili, Nyanchwa, and Mwembe) whose waste waters are directed to the nearing rivers and streams. Following this, an impermeable base floor will be constructed with tunnels that will drain the waste water to a reservoir tank. The waste water from the reservoir tank will then be subjected to the physical filtration system.

3.2 Materials

Gravel, Silicon (iv) oxide , Cement, Activated carbon, Cotton wool, Cylindrical plastic tanks, PVC pipes, Gate valves, Reservoir tanks, Lab analysis of water parameters, Construction tools and equipments, building blocks.

3.3 Structural design

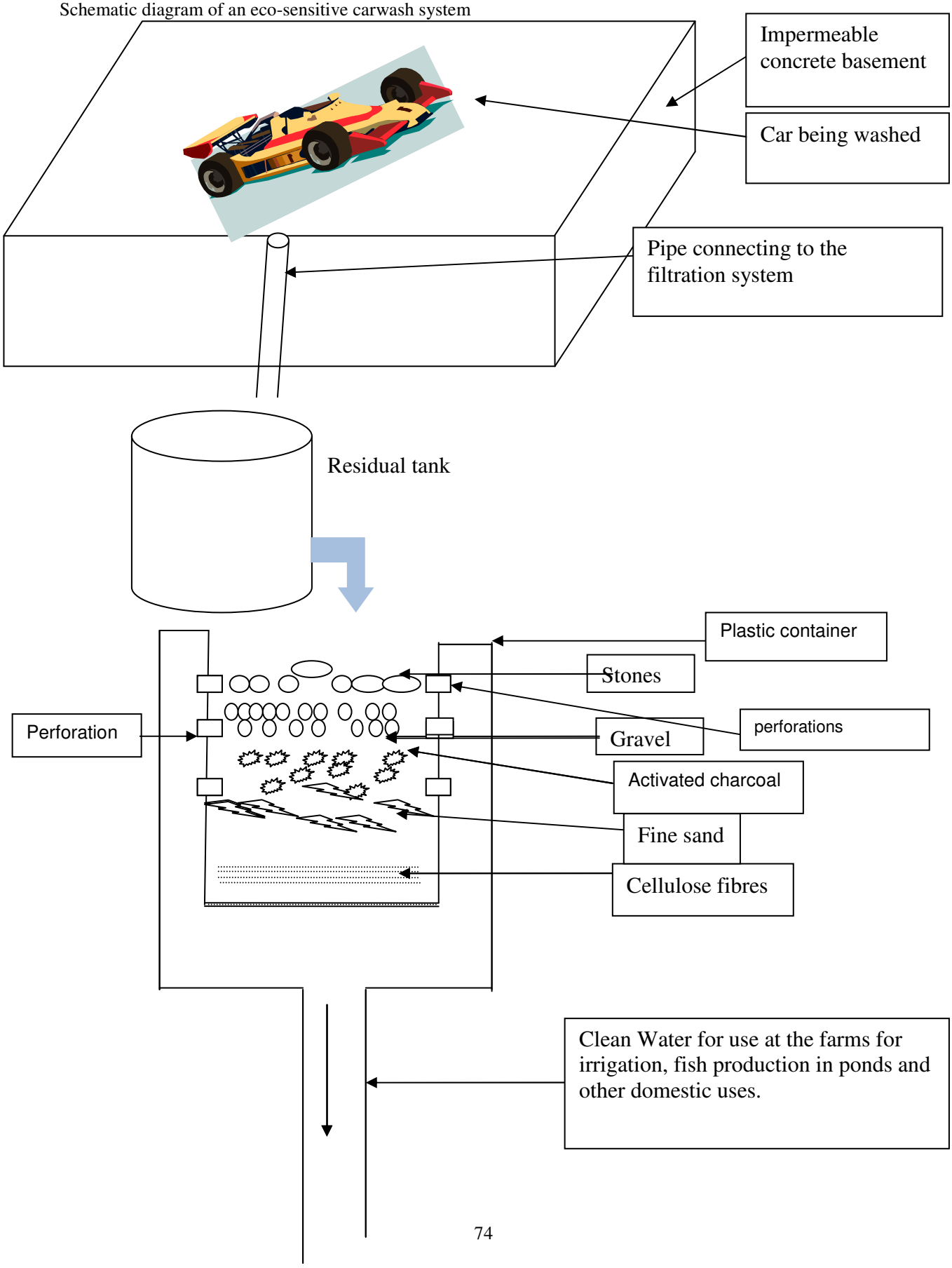
The design of the physical filtration system will have a life span of 2-3 years and will constitute of a cylindrical container that assumes a man hole like structure arranged from top-bottom materials of decreasing sizes as follows: large gravel, pebbles, sand, cellulose, activated carbon and cellulose to do filtration and adsorption backwashing as regenerative clean up mechanism. Layers of gravel and sand will remove suspended solids. When water flows through the sand filter, the suspended solids precipitate in the sand layers as residue and the water which is reduced in suspended solids flows out of the filter.

Another layer of activated carbon which is one of the most effective media for removing a wide range of contaminants from industrial, municipal, and carwash waste waters, landfill leachate and contaminated groundwater, follows. Activated carbon is an adsorbent; it can cope with a wide range of contaminants. Different contaminants present in the same discharge and carbon will be used to treat the total flow, or it may be better utilised to remove specific contaminants as part of the system process. Smaller suspended solids have the ability to pass through the activated carbon filter, needing an additional step of cotton filter to arrest bacteria and other microbes as well.

The purified water will be directed to a holding lagoon with the phytoremediation plants to filter dissolved chemical contaminants from the water. The clean water from the phytoremediation process in the lagoon will

then be directed either to the river or to a pond to rear commercially beneficial fish. The waste water from the pond which is rich in ammonia is used for irrigation of horticultural crops and fertilised by nitrates which are essential for plant growth and development.

Schematic diagram of an eco-sensitive carwash system



4.0 Results

The project legitimizes more car washing bays along river ecosystems more especially at Daraja-moja, and in Nyambera where in river car washing activity takes place. The sanitary or ecological sensitive carwash creates more employment opportunities and more incomes realised in the families boosting the economy of the county as well as enhancing living standards. Clean water supply is enhanced and water borne diseases drastically reduced among residents dependent on the water for industrial and domestic use.
The project catalyses more revenue generation and collection for the county through fish farming from the clean water, and more horticultural production as well as eco-tourism from other counties and international visitors who visit the site to understand the technology.

The project stimulates the environmental integrity of the county which leads to low incidences of water borne diseases. Replication of the project in other parts of the county shall lead to more direct job opportunities in the county and country.

5.0 Conclusion

The project is feasible, self-sustaining, promising and is geared towards achievement of millennium development goals [hunger and job creation] and also vision 2030's achievement of a sustainable environment.
Implementation of the project will enhance access to high quality of water in the region and will attract more investors and even tourists to the County, and this will unfold the issues relating to revenue collection, water borne diseases, unemployment, income for better living standards and food for the increasingly rising Kisii county citizen populations.

Suggested works

1. A pressure pump should be in place for backwashing of the system to wash all the coagulants that get suspended in the system.
2. Regular laboratory tests are done to check the validity and reliability of the project
3. Regular visitations to the system sites to check on its operation are critical for high efficiency.

References

Ahluwalia, S. S.& Goyal, D. (2007). Microbial and plant derived biomass for removal of heavy metals from wastewater. 98 (12), 2243-2257.

Chong, A. M. Y.,Wong, Y. S., & Tam, N. F. Y.(2000). Performance of different micro-algal species in removing nickel and zinc from industrial wastewater. *Chemosphere* 41, 251-257.

Fergusson J. E., (1990). The Heavy Elements: Chemistry, Environmental Impact, and Health Effects. New Zealand, Pergamon Press, 431.

Kurniawan, T. A.,Chan, G. Y. S., Loa, W. H., & Babel, S. (2006). Physico-chemical treatment techniques for wastewater laden with heavy metals. *Chemical Engineering Journal*, 118, 83-98.

Malik, A., (2004). Metal bioremediation through growing cells. *Environment International*. 0 (2), 261-278.
Volesky, B.& Schiewer S., (2000). Biosorption, Metals. Encyclopedia of Bioprocess Technology. (Fermentation, Biocatalysis and Bioseparation)1, 433-453.

Zhang, Z., Zeng, G. M.,Huang, J. H., Fang, Y. Y., Xu, K., Qul, Y. H.,Yang Ch. P.& Li, J. B. (2007). Removal of zinc ions from aqueous solution using micelle - enhanced ultra filtration at low surfactant concentrations. Water research commission 33.

First author .Tom Nyangau was born in Kenya on 26th march 1967,studied at Kenyatta university – Kenya 1993 [BSc, Botany, zoology and chemistry], Egerton university- Kenya 1998 [postgraduate diploma in education] MSc Environmental monitoring[Nottingham Trent University-UK, 2004] and PhD Education[Clayton- university, North-London college-UK2009] .